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Deglacial evolution of regional Antarctic climate and Southern Ocean conditions in transient climate simulations

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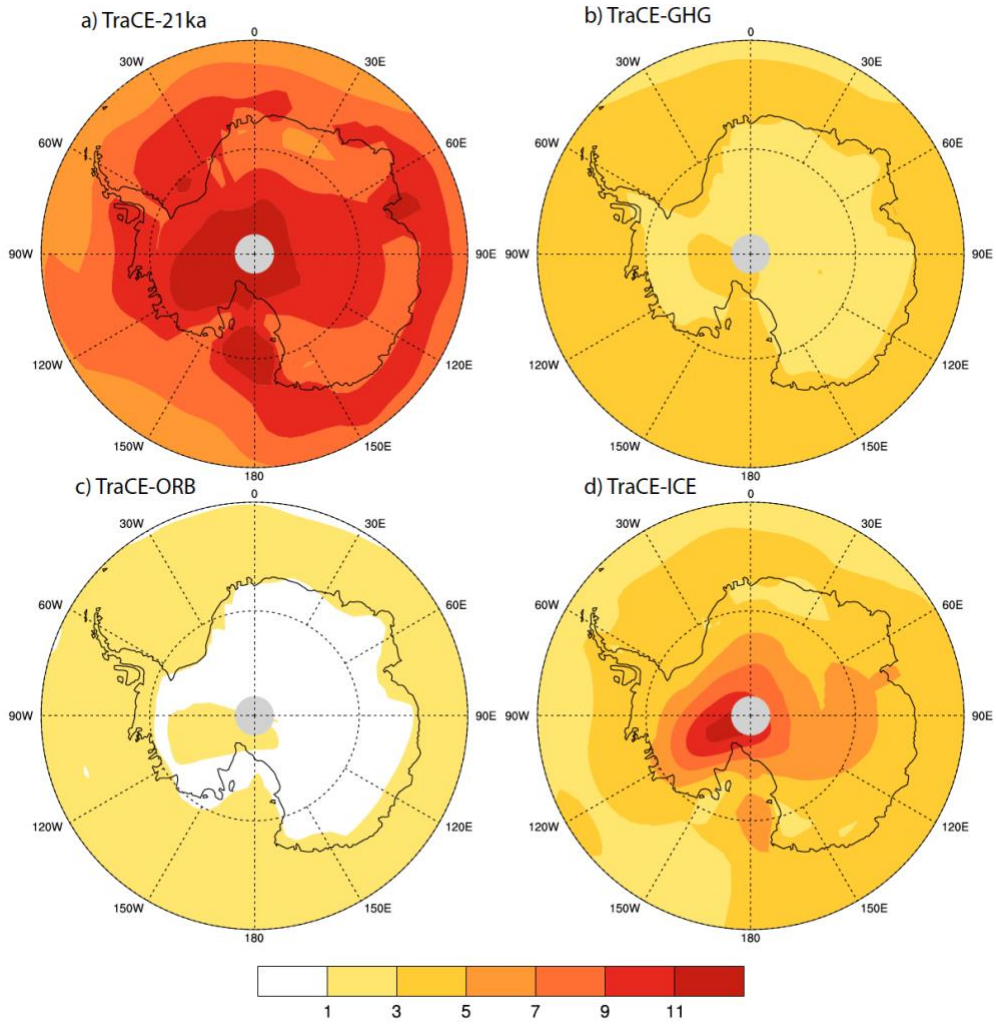
Supplemental Information

TraCE-21ka Sensitivity Experiments

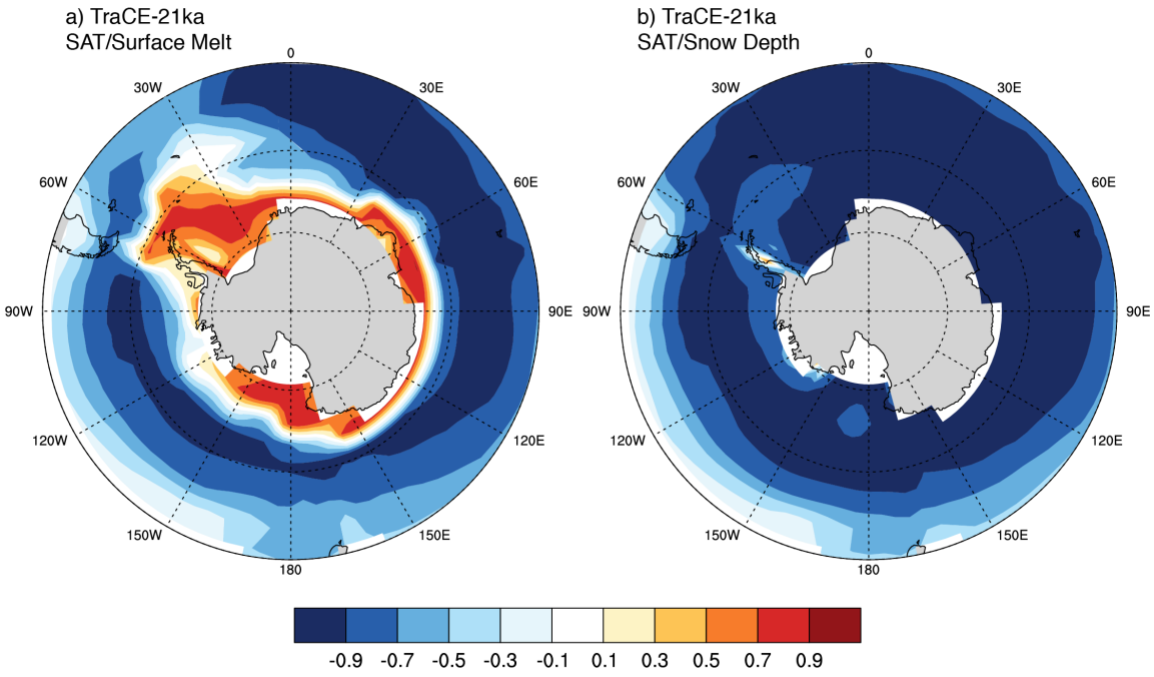
To attribute the causes of surface temperature changes in the TraCE-21ka experiment, we analyze three additional transient sensitivity experiments of each individual forcing using the CCSM3 model (He et al., 2013): TraCE-ORB, with only transient orbital forcing, and all other forcings and boundary conditions remaining at the TraCE state of 22ka; TraCE-GHG, with only transient greenhouse gas forcing, and all other forcings and boundary conditions remaining at the TraCE state of 22ka; TraCE-ICE, with only changing continental ice sheets, and all other forcings and boundary conditions remaining at the TraCE state of 19ka. TraCE-GHG and TraCE-ORB show the strongest warming occurring over the Southern Ocean, the continental margins, and interior West Antarctica, but the continental surface warming in these experiments is relatively minor compared to that in TraCE-ICE. The TraCE-ICE experiment demonstrates that the majority of the surface warming that occurs in West Antarctica and over the Antarctic Plateau can be explained by the decrease in ice surface elevation rather than changes in radiative forcing.



SI Fig. 1. Surface temperature warming (°C) from 18 kyr to 6.5 kyr in (a) TraCE-21ka and three transient sensitivity experiments.

Surface albedo over the Southern Ocean

Although the sea ice concentration is the strongest control of surface albedo over the Southern Ocean in the climate model simulations, it is not the only contributing factor. In addition to sea ice concentration, the surface albedo parameterization of both models accounts for the state of the sea ice surface (i.e., freezing or melting, snow coverage; Briegleb et al., 2004; Goosse et al., 2010). The TraCE-21ka simulation also depends on the snow depth and snow age. We observe strong correlations between surface air temperature and sea ice surface melt and snow depth over the Southern Ocean in TraCE-21ka (SI Fig. 2). These outputs are unavailable for the DG_{ns} simulation.



SI Fig. 2. Spatial Pearson linear cross-correlation coefficients (r) between decadal surface air temperature (SAT, °C) and (a) sea ice surface melt (cm day^{-1}), and (b) sea ice snow depth (m) for TraCE-21ka. Sea ice surface melt and snow depth output were re-gridded to the same grid resolution of SAT using bilinear interpolation.

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